Title:

POLICY-BASED QOS MANAGEMENT IN MULTI-RADIO ACCESS NETWORKS

Management

Description

Field of the Invention

The present invention relates to a system and method for providing a policy based Quality-of-Service management in multi-radio access mobile networks.

Background of the Invention

Mobile networks are subject to a big expansion over the world in the sense of major diversity of devices and services. With respect to a best-effort service model, mobile networks are intended to support different service levels for specific Quality-of-Service (QoS) requirements.

However, this growth in network usage and technology has increased the network management complexity in fields such as Quality-of-Service. Hence, the main challenge is the complexity for operators to manage their networks in a simple way and to offer the possibility to regulate the access to network resources based on categories such as user profiles or applications. An additional complexity arises from the management of multi-radio networks, e.g. when an operator deploys a WCDMA (Wideband Code Division Multiple Access) and a GSM/GPRS (Global System for Mobile Communication/General Packet Radio System) network simultaneously.

In addition to the heterogeneity of new services with different Quality-of-Service requirements, the management

of networks becomes more complex due to technology
divergence, i.e. the presence of multi-radio access
networks (GERAN - GSM EDGE Radio Access Network, UTRAN -
Universal Terrestrial Radio Access Network), and the growth
in the complexity of the network elements, i.e. many
parameters take influence on the functions thereof.

Summary of the Invention

Therefore, it is an object of the present invention to deal
with the above described problems.

According to the present invention, the problem of managing
complex networks is solved with a policy management system
and method which are system level unified for managing the
Quality-of-Service in multi-radio access mobile networks.

Precisely, there is provided a system for providing a
policy based Quality-of-Service management in multi-radio
access mobile networks, comprising: control center means
for administrating said radio access networks, thereby
controlling the behavior thereof, wherein an information
model is implemented in said control center means which
describes different Quality-of-Service mechanisms including
attributes which are involved in each function under policy
thus representing the manageable parameters of specific
network implementations, and wherein said information model
forms the basis of a set of policy rules defining actions
to be executed in dependency of the occurrence of
conditions; and a policy based management device adapted to
receive said set of rules for the implementation thereof,
said device having a plurality of policy based radio
resource management means each adapted for managing said
parameters of specific network implementations, and a
translation function means adapted to translate said rules

in a form executable by said plurality of policy based
radio resource management means.

In addition, there is provided a method of providing a
policy based Quality-of-Service management in multi-radio
access mobile networks, comprising the steps of: defining
an information model by modeling radio Quality-of-Service
functions, abstracting implementation details from
configuration and management parameters thereof,
identifying manageable parameters of these, and building
policy rules for the execution of certain actions in
dependency of the occurrence of certain conditions among
said manageable parameters; evaluating the conditions; and
executing, in dependency from said evaluation step, those
actions which are prescribed by said policy rules as a
consequence from the occurrence of certain conditions,
wherein said policy rules are administrated by a central
controlling point if they take effect on the
Quality-of-Service behavior at the network level.

According to the policy based radio resource management of
the present invention, a centralized control point is
offered which administrates the network in order to achieve
a consistent service behavior for the need of a specific
Quality-of-Service. That means that all Quality-of-Service
related functions distributed in the radio access network
could be managed from a central point of administration. In
addition, policy based radio is an integral part of a
larger network-wide policy management framework, so that
the operator's network-wide policy can be enforced
consistently across radio (L2) technologies which are
independent from each other.

Furthermore, the policy based management according to the
present invention allows to allocate resources in terms of

business decisions, since abstracted management data can be used. For abstraction purposes, an information model describes the different Quality-of-Service mechanisms, including the attributes involved in each function under policy. The informal management model is intended to be abstract and capable of representing the manageable parameters for a variety of specific radio access network element implementations.

According to the present invention, a policy based management is provided by means of which a network administrator is able to configure a set of rules expressed, for example, in human (business) vocabulary. These rules are independent of the radio access technology, since the policy based management system hides the implementation technologic details. The policy management system translates high level policies (service policies) into network specific policies, which can be understood and enforced by the multi-radio resource management (RRM) functions (i.e. both GERAN and UTRAN RRM).

The policy based radio resource management, which is part of the policy based management tool, is responsible for managing Quality-of-Service in radio access networks (RAN), thereby covering functions like admission control for new Radio Access Bearers (RAB) and Radio Bearers (RB) or a dynamic configuration of the packet scheduler, the load control or of quality control parameters. From the viewpoint of policy management, those radio resource management (RRM) functions of different radio technology are modeled as black boxes which provide certain "services" towards the policy management system. The services of the functionality are described by an information model which is common for different kinds of radio resource management (RRM) implementations. It is also possible that one radio

specific technology comprises a subset of the full service capability.

On the abstract level, the service capability of a radio resource management (RRM) black box can be seen as a Differentiated Service - able router containing a Quality-of-Service agent (i.e. having signaling capability). The radio resource management (RRM) black box contains e.g. a traffic classification, a queue management (packet dropper, en-queuing, and scheduling), a flow based admission control, and flow based quality control functions, for both uplink and downlink traffic. Each of these functions has a set of configurable attributes, which can be set by a policy server. The radio resource management (RRM) black box can be either WCDMA or GERAN, or a multi-radio network of WCDMA and GERAN, WLAN (Wireless Local Area Network) or some other system. For a multi-radio RRM black box, the policy manager controls all resources of the different networks.

According to the present invention, the policy based management allows to control the behavior of the boxes (e.g. the throughput and the delay distributions) for different types of traffic flow.

Advantageous modifications of the present invention are defined in the appended dependent claims, while further details of the present invention are apparent from the following description of the embodiments thereof which is to be taken in conjunction with the appended drawings, in which:

Fig. 1 shows a policy-based Quality-of-Service management;

Fig. 2 shows a system management model;

Fig. 3 shows a policy model; and

Fig. 4 shows a radio Quality-of-Service functional block
coordination.

Preferred Embodiments of the present Invention

By referring to fig. 1, a policy-based Quality-of-Service
management according to the present invention is described.

As depicted in the figure, a network administrator is able
to configure a set of rules expressed, for example, in
human (business) vocabulary. The rules are independent of
the radio access technology, since the policy-based
management hides those technologic implementation details.
Furthermore, there is a function translating high level
policies (service policies) into network specific policies,
which are processable by the radio resource management
(RRM) functions. Moreover, those network specific policies
are applicable to multi-radio access networks, i.e. to
radio resource management functions of e.g. both GERAN and
UTRAN.

Next, a system management model according to the present
invention is described with reference to fig. 2.

The different radio resource management functions, such as
e.g. a packet scheduler PS, an admission control AC and a
quality control QC, are modeled as black boxes, where only
the functionality and the parameters controlling its
behavior are important. From the whole set of parameters,
only a subset of them are selected to be managed by the
policy rules. The selected parameters are those impacting
on the Quality-of-Service provision and those the value of

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which can dynamically be varied by the operator, unlike
configuration parameters. In the figure, this idea is
outlined by means of two types of arrows: those interacting
with the policy server and those remaining within the radio
resource management subsystem which can not be dynamically
configured by the operator.

Furthermore, the multi-radio resource management system is
seen as a black box by the policy server. The inputs of the
system are different traffic flows with different
Quality-of-Service requirements (traffic class, user
profile, guaranteed bit rate, transfer delay, etc.),
whereas the outputs are those traffic flows with a
determined Quality-of-Service provision, e.g. a determined
throughput distribution and delay distribution. As a
consequence, the policy based management according to the
present invention allows to control the behavior of the
system (e.g. throughput and delay distributions) for
different types of traffic flow. This idea is depicted in
the figure by means of two different cumulative
distribution functions CDF of the throughput as produced by
two different sets of values of the policy parameters.

Referring now to fig. 3, the policy model according to the
present invention is described hereinafter.

This policy model is composed by three types of entities: A
policy repository is the location containing high-level
policies as defined by the administrator which can be
applied within the policy domain. A policy enforcement
point PEP represents the entity whose behavior is going to
be managed by the policy rules. A policy decision point PDP
represents a group of functions in charge of acquiring,
deploying, and optionally translating policy rules into a

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form understandable and thus executable by a policy
enforcement point PEP.

The downloading of the rules from the policy decision
points PDP into the policy enforcement points PEP is
effected by a policy information base PIB which contains
the possible rules of all relevant functions of a specific
device. The policy enforcement points PEP are monitored and
provided with simple configuration tasks by a management
information base MIB which informs about the behavior of
the policy enforcement points PEP. The management
information base MIB is defined for monitoring and behavior
control purposes.

Moreover, with reference to fig. 4 a radio
Quality-of-Service functional blocks coordination is
described below.

The components and combinations of components as described
in the figure form building blocks that need to be
manageable by radio access network configuration and
management tools. This model is in the form of a connected
Directed Acyclic Graph (DAG) of elements that describes not
only the admission control and resource management
functions at the service activation, but also the traffic
conditioning and queuing behaviors which any particular
packet will experience when forwarded to the radio
interface.

Radio configuration and performance indicator operating
parameters are monitored and provisioned through the
management interface. The monitored parameters include
statistics regarding a traffic carried at various
Quality-of-Service levels. The network administrator
interacts with the radio element configuration and

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management interfaces via one or more management protocols,
such as the Simple Network Management Protocol (SNMP) or
the Common Open Policy Service (COPS), or through other
configuration tools such as the Remote Authentication
Dial-in User Service (RADIUS) or the Lightweight Directory
Access Protocol (LDAP).

In the following, the preferred embodiments of the present
invention are described in even more detail by referring to
the above.

In order to apply a proper policy management to the radio
domain, different radio Quality-of-Service functions must
be modeled abstracting the implementation details from the
parameters of interest for configuration and management.
Once the manageable parameters are identified, the operator
is able to build policy rules in the form "IF condition
THEN action".

The semantics of a policy rule are such that if the set of
conditions evaluates to TRUE then the set of actions are
executed. The scope of these rules can vary: Global
policies will have a global effect on the overall result of
applying the given policy. That is, the end result of such
policy relies on it being executed globally across the
entire path of network service. Further, domain policies
are meaningful within one domain of Quality-of-Service
mechanisms, e.g. a radio domain, whereas local policies are
only meaningful within one network element. From the
viewpoint of rule management, it is very essential that the
global and domain policies are harmonized. This target is
presently considered to be easiest achieved by means of a
central controlling point. Local policies can reside within
the control of a corresponding local element, so long as

such local policies have no effect on the
Quality-of-Service globally.

In the radio domain, most of the policy decision functions
are distributed into various control and user plane logical
elements, so that dynamic policy decisions, in particular
the time critical ones, can be made locally based on local
dynamic conditions. However, the service logic of these
policy decision elements is under the control and
administration of a policy server.

Policy information must be transmitted to a network device
for the purpose of configuring the policy at that device
(see fig. 3). The policy information base PIB defines the
data structure by which the policy decision point PDP
downloads the policy into a policy enforcement point PEP.
Each policy information base PIB contains the possible
rules of all relevant functions of a specific device. In
addition, the management information base MIB is defined
for the purpose of monitoring and simple configuration of
network devices. The management information base MIB
defines the device specific data structure by which the
policy enforcement point PEP may inform its behavior to the
policy decision point PDP.

A policy infrastructure is that set of protocols,
information models, and services that allow administrative
and business intentions to be translated into a
differential packet treatment of network packet flows.

The exchange of information between different types of
entities needs the use of protocols in charge of that (see
fig. 3). The Common Open Policy Service COPS protocol is a
client-server protocol intended for the communication of
policy requests and decisions between a policy enforcement

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point PEP and a policy decision point PDP. The Common Open
Policy Service COPS is characterized by its reliability and
fault-tolerance unlike a legacy control protocol such as
the Simple Network Management Protocol SNMP. Furthermore,
the Common Open Policy Service COPS is flexible and easy to
use for both a dynamic and static configuration. Depending
on the type of policy repository, the access to the policy
repository can be performed by different protocols such as
the Lightweight Directory Access Protocol LDAP or the
Structured Query Language SQL.

The first step towards the policy management is defining an
information model to describe the different
Quality-of-Service mechanisms, including the attributes
involved in each function that can be under policy (see
fig. 2). The informal management model is intended to be
abstract and capable of representing the manageable
parameters for a variety of specific radio access network
element implementations. This model serves as the rationale
for the design of the policy information bases PIB of the
different network elements.

The policy management in the radio domain is responsible
for managing the Quality-of-Service in the radio access
network, covering functions like admission control AC for
new radio access bearers RAB and radio bearers RB or
dynamically configuring the packet scheduler, load control
or quality control parameters. Those radio resource
management functions are modeled as black boxes, where it
is only the functionality and the parameters controlling
its behavior are important. The selected parameters are
those impacting on the Quality-of-Service provision and
operators can dynamically vary its value, unlike
configuration parameters. In addition, the multi-radio RRM
system is seen as a black box by the policy server (see

fig. 1). The inputs of the system are different traffic
flows with different Quality-of-Service requirements
(traffic class, user profile, guaranteed bit rate, transfer
delay, etc.), whereas the outputs are those traffic flows
with a determined Quality-of-Service provision, e.g. a
determined throughput distribution and delay distribution.
As a consequence, the policy based management according to
the present invention allows to control the behavior of the
system (e.g. the throughput and delay distributions) for
different types of traffic flow.

By means of the policy based management according to the
present invention, a network administrator is able to
configure a set of rules expressed, for example, in human
(business) vocabulary and being independent of the radio
access technology, since the policy based management hides
those implementation technologic details (see fig. 1). The
policy server translates high level policies (service
policies) into network specific policies, which are
understandable and executable by the radio resource
management functions. Moreover, those network specific
policies are applicable to multi-radio access networks,
i.e. to radio resource management functions of both GERAN
and UTRAN.

Next it is described what is presently considered as the
best mode of implementing the present invention.

The present invention can be implemented with a policy
server type of product, which comprises a user interface
for the network administrator to enter and/or select a
policy. In addition, there is a configuration data base
present where all parameters are stored. It is a function
of the policy server that a submitted policy is checked
first for service logic consistency, and consequently a new

or updated data structure is generated based on the policy
update. The data structure is element specific.

The exchange of information between different types of
entities (i.e. a policy decision point PDP and a policy
enforcement point PEP) needs the use of protocols in charge
thereof. The Common Open Policy Service COPS protocol is a
client-server protocol intended for the communication of
policy requests and decisions between a policy enforcement
point PEP and a policy decision point PDP. The Common Open
Policy Service COPS is characterized by its reliability and
fault-tolerance unlike legacy control protocols such as the
Simple Network Management Protocol (SNMP). Furthermore, the
Common Open Policy Service COPS is flexible and easy to use
for both a dynamic and static configuration. Depending on
the type of policy repository, the access to the policy
repository can be performed by different protocols such as
the Lightweight Directory Access Protocol (LDAP) or the
Structured Query Language (SQL).

Thus, important features are how policy based management is
performed and that the policy server product is able to
configure radio (see as L2) Quality-of-Service functions to
be consistent with the network layer Quality-of-Server
policy, according to the operator network wide policy. This
is visible in the policy server user interface. In
addition, the policy server is able to configure multiple
radio technology with one set of rules corresponding to the
information model as used by multiple radio technologies in
the network.

In summary, what is described above is a system for
providing a policy based Quality-of-Service management in
multi-radio access mobile networks, comprising: control
center means for administrating said radio access networks,

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thereby controlling the behavior thereof, wherein an information model is implemented in said control center means which describes different Quality-of-Service mechanisms including attributes which are involved in each function under policy thus representing the manageable parameters of specific network implementations, and wherein said information model forms the basis of a set of policy rules defining actions to be executed in dependency of the occurrence of conditions; and a policy based management device adapted to receive said set of rules for the implementation thereof, said device having a plurality of policy based radio resource management means each adapted for managing said parameters of specific network implementations, and a translation function means adapted to translate said rules in a form executable by said plurality of policy based radio resource management means.

In addition, there is provided a method of providing a policy based Quality-of-Service management in multi-radio access mobile networks, comprising the steps of: defining an information model by modeling radio Quality-of-Service functions, abstracting implementation details from configuration and management parameters thereof, identifying manageable parameters of these, and building policy rules for the execution of certain actions in dependency of the occurrence of certain conditions among said manageable parameters; evaluating the conditions; and executing, in dependency from said evaluation step, those actions which are prescribed by said policy rules as a consequence from the occurrence of certain conditions, wherein said policy rules are administrated by a central controlling point if they take effect on the Quality-of-Service behavior at the network level.

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While it is described above what is presently considered as the preferred embodiments of the present invention it is apparent to those skilled in the art that various modifications thereof are possible without departing from the scope of the present invention which is defined by what is set out in the appended claims.